Regional growth and development theories revisited

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REGIONAL GROWTH AND DEVELOPMENT THEORIES REVISITED

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Abstract

Regional economics has a long tradition in analytical research and policy modelling, with the aim to enhance our understanding of regional competitiveness conditions and of the emergence, persistence, and mitigation of spatial socio-economic disparities. Unequal regional development in our open economy has prompted a long-lasting debate on the validity and usefulness of economic growth theories in a regional context. This paper aims to review various contributions to regional growth theory and regional policy analysis. It addresses both established regional growth theories and modern growth theories based on, for example, endogenous growth concepts. The paper also broadens the discussion by drawing attention to the importance of network ramifications and environmental sustainability for regional development. It concludes with the formulation of an agenda for future research.

1. Trends in Regional Economic Growth Theory

Regional development covers a wide range of economic policy issues related to the need to exploit appropriate productive resources that may contribute – or form an impediment – to the welfare of a region (in either an absolute or a relative sense). Consequently, regional development is associated with both efficiency objectives (such as the optimal use of scarce factor inputs) and equity objectives (such as social cohesion and distribution of wealth, issues in modern jargon sometimes referred to as "territorial cohesion"). Clearly, such elements are also prominent in conventional macroeconomic growth analysis (e.g. at a national scale), but a special reason for giving explicit attention to regional economic growth lies in the relatively small and open character of a region (or a system of regions). Since a region forms an intermediate or hybrid spatial unit between a nation and its citizens, regional economic growth theory uses elements from both macroeconomic growth policy and individual welfare theory.

Against the background of the previous observations, it comes as no surprise that in recent years endogenous growth theory has gained much popularity in regional economics; it is essentially a blend of microeconomics and macroeconomic growth theory, in which smart use of the indigenous resources of a region plays a critical role. It covers, inter alia, the linkages between income, employment, investments, infrastructure, and suprastructure. In particular, much emphasis is placed on the study of spatial socio-economic disparities or convergence (including labour migration), with a particular view to the way spatial disparities can be influenced by the deliberate actions of stakeholders (e.g. industry, government).

It is thus increasingly recognized that regional development is not only a spatial efficiency issue in economic policy. It is also an equity issue, because economic development normally exhibits a significant degree of spatial variability, and, furthermore, it is increasingly conceived of as a spatial sustainability issue with strong regional and urban dimensions. Over the past few decades, the continuous concern about unbalanced regional development has prompted various strands of important research literature, in particular: the measurement of interregional disparity; the causal explanation for the emergence or persistent presence of spatial variability in economic development; and the impact assessment of policy measures aimed at coping with undesirable spatial inequity conditions. The study of socio-economic processes and inequalities at the meso-scale and regional levels positions regions as the core places of policy action, and hence warrants intensive conceptual and applied research efforts.

Clearly, the economic analysis of regional growth and its distribution already has a long history and dates back to classical economists such as Adam Smith and Alfred Marshall. From an analytical perspective, the foundations of modern economic growth theory can be found in the early work of Solow (1956), in which he argues that, in a neoclassical economic world, the growth rate of a region (measured in per capita income) is inversely related to its initial per capita income, a thesis which offers an optimistic perspective for poor regions. Interesting regional growth models have been extensively developed in the 1960s, in particular in a neoclassical framework (Borts, 1960;

Borts and Stein, 1964 and 1968). The spatial-economic convergence idea has attracted considerable attention over the years and has generated interesting applied research on evolving convergence versus persistent disparities (see, e.g., Barro and Sala-i-Martin, 1992). In addition to statistical analysis, this research and policy issue has also led to new insights into the contextual drivers of disparities, such as mobility, product diversification, monopolistic competition, institutional impediments, etc.

It is thus clear that, over the past few decades, a persistent unequal distribution of welfare among regions and/or cities has been a source of concern and inspiration for both policy makers and researchers. Regional development is at the heart of this concern, as it is about the geography of welfare and its evolution. It has played a central role in such disciplines as economic geography, regional economics, regional science, and economic growth theory. The concept is not static in nature, but refers to complex space-time dynamics of regions (or an interdependent set of regions). In addition, the actual measurement is also dependent on the geographical scale used. Changing regional welfare positions are often hard to measure, especially in a comparative multi-regional context. In practice, we often use Gross Domestic Product (GDP) per capita (or growth therein) as a statistical approximation (see Stimson et al., 2006). Sometimes alternative or complementary measures are also used, such as per-capita consumption, poverty rates, unemployment rates, labour force participation rates, or access to public services. These indicators are more social in nature and are often used in United Nations welfare comparisons. An example of a rather popular index in this framework is the Human Development Index which represents the welfare position of regions or nations on a 0-1 scale using quantifiable standardized social data (such as employment, life expectancy, or adult literacy) (see, e.g., Cameron, 2005). In all cases, however, spatial socio-economic disparity indicators show much variability.

The history of economic research has witnessed an ongoing debate on income convergence among countries or regions, both theoretically and empirically, often with due emphasis on effective and efficient policy measures and strategies. This continues to be an important research topic, since regional disparities may have significant negative socio-economic cost consequences because of, for instance, social welfare transfers, inefficient production systems (e.g. due to the inefficient allocation of resources), and undesirable social conditions (see Gilles, 1998). In a neoclassical framework of analysis, these disparities (e.g. in terms of per capita income) are assumed to vanish in the long run, because of the spatial mobility of production factors which ultimately results in an equalization of factor productivity in all regions. Clearly, long-range factors, such as education, R&D, and technology, play a critical structural role in this context. In the short run, however, regional disparities may show rather persistent trends (see also Patuelli, 2007).

Interregional disparities can be – as mentioned above – measured using various relevant categories, such as (un)employment, income, investment, growth, etc. Clearly, such indicators are not entirely independent, as, for instance, is illustrated in Okun's law, which assumes a relationship between economic output and unemployment (see Okun, 1970; Paldam, 1987). The empirical

research on convergence has often been based on cross-sectional analysis, e.g. on the basis of concepts related to beta-convergence and sigma-convergence (see, e.g., Baumol, 1986; and Barro, 1991). More recently, time-series analysis has also been used extensively, based on notions from stationary time processes (see, e.g., Bernard and Durlauf, 1995). The findings from these different strands of the literature are not always identical, however, and in recent years this has stimulated new research efforts inspired by endogenous growth theory. The convergence of regional disparities is clearly a complex phenomenon, as it refers to a variety of mechanisms through which differences in welfare between regions may vanish (see Armstrong, 1995). In the modern convergence debate, we observe increasingly more attention to the openness of spatial systems, reflected, inter alia, in trade, labour mobility, commuting etc. (see, e.g., Magrini, 2004). In a comparative static sense, convergence may have various meanings in a discussion on a possible reduction in spatial disparities among regions (see also Barro and Sala-i-Martin, 1992; Baumol, 1986; Bernard and Durlauf, 1996; Boldrin and Canova, 2001). In particular, there is:

- β-convergence: a negative relationship between per capita income growth and the level of per capita income in the initial period (e.g. poor regions grow faster than initially rich regions);
- σ-convergence: a decline in the dispersion of per capita income between regions over time.

The convergence hypothesis in neo-classical economics has been widely accepted and discussed in the literature, but is critically dependent on two hypotheses (see Cheshire and Carbonaro, 1995; Dewhurst and Mutis-Gaitan, 1995):

- diminishing returns to scale in capital should prevail, which means that output growth will be less than proportional with respect to capital;
- technological progress will generate benefits that also decrease with its accumulation (i.e. diminishing returns).

A wealth of studies have been carried out to estimate the degree of β-convergence and σ-convergence (see, e.g., Barro and Sala-i-Martin, 1991, 1992). The general findings are that the rate of β-convergence is in the order of magnitude of 2 per cent annually, while the degree of σ-convergence tends to decline over time, for both US states and European regions. Clearly, there is still an ongoing debate worldwide on the type of socio-economic convergence, its speed, its multidimensional conceptualization, and its causal significance in the context of regional policy measures (see, e.g., Fagerberg and Verspagen, 1996; Fingleton, 1999; Galor, 1996). Important research topics in the current literature appear to be: the role of knowledge and entrepreneurship; spatial heterogeneity in locational or socio-cultural conditions; and institutional and physical barriers. An important new topic in the field is group convergence (or club convergence), which means a convergence of sets of regions towards a more homogeneous cluster.[1]

[1] For further discussion on club convergence, we refer to Baumont et al., 2003; Chatterji, 1992; Chatterji and Dewhurst, 1996; Fischer and Stirbock, 2006; Islam, 2003;López-Bazo et al., 1999; Quah, 1996; Rey and Montouri, 1999; and Sala-i-Martin, 1996.

We may conclude that the research field of spatial disparities is still developing and is prompting fascinating policy issues that deserve in-depth attention in the years ahead. Besides the concern on policy issues, also in the academic arena too much interest has arisen over the last decade in spatial development. The degree of scientific consensus – as well as the degree of cross-fertilization of ideas – between regional economists and mainstream economists has led to interesting debates in regional science circles.

In addition, in a period of globalization (including financial crises) and of the creation of broad single-currency areas, regions (and also nations) have to keep an eye on the competitiveness of their production systems, because no spontaneous or automatic adjustment mechanism is yet at work to counterbalance a lack (or an insufficient growth rate) of productivity. Local specificities and local material and non-material assets (including knowledge and learning mechanisms) become strategic elements upon which the competitiveness of regions is based. More than ever, theories of regional growth and development need to be able to interpret the way in which regions achieve a role in the international division of labour and, more important, the way in which regions can maintain this role over time.

And, finally, it should be recognized that regional growth trajectories are often confronted with sustainability issues and scarcity of environmental resources, such as environmental quality, natural resource security, urban quality of life, or spatial biodiversity. Such important issues are increasingly a critical element of a regional welfare function. Some sustainability elements may be interpreted in terms of scarce input factors, such as bio-ethanol, solar, or wind energy, while others are seen as welfare constituents, such as the quality of the living environment. This new scarcity has important spatial components and has to be analysed from the perspective of regional development as well. Consequently, regional development is not only a matter of regional competition for the use of scarce resources but also a matter of creating the environmental conditions for sustainable wealth creation and enjoyment. This calls increasingly for a broader welfare interpretation of regional growth, in which the triangle of efficiency, equity and sustainability form the driving forces of regional development.

The aim of this paper is to present a selection of recent contributions that explain regional growth and local development, with the aim to highlight: (i) recent advances in theories; (ii) policy implications of these theories; and (iii) cross-fertilization of ideas among regional economists and mainstream economists. First, Section 2 presents the theoretical advances on regional growth achieved in recent years in different parts of the world. Section 3 addresses sustainability issues from a regional perspective, while Section 4 gives an overview of future challenges in this field. Finally, Section 5 provides concluding remarks.

2. Developments in Regional Growth Theory

As mentioned in Section 1, the complex issue of regional development and growth has been a focal point of interest in recent decades. The great number of relatively new and advanced

contributions in the area of regional development/growth theories does not allow us to offer a detailed review of all individual achievements made; moreover, a detailed presentation of all new ideas would probably not be very stimulating. Our view is that selective and focussed attempts to highlight general theoretical trends offers a more fruitful basis for a debate on current weaknesses and on possible future directions of regional economics. Inevitably, the set of 'mega-trends' in regional growth analysis offered in this section is both selective and incomplete (Capello, 2008a).

Table 1 summarizes the two main 'mega-trends' that, in our view, largely characterize the theoretical developments over the last two decades in regional economics, and that are common to urban economics and to many other disciplines (Capello and Nijkamp, 2004)[2]: the need for more realism, and the move towards dynamic rather than static approaches. These theoretical perspectives are presented in Table 1 for both regional growth and regional development theories, the former aiming at explaining the aggregate growth rate of income and employment in a formalized and quantitative way, the latter oriented towards the identification of all tangible and intangible qualitative elements of the growth process of regions.

Table 1. Main Tendencies in Theories of Regional Economics

Theories / *Tendencies in theories*	*Regional growth theories*	*Regional development theories*
More realism in theoretical approaches	Endogenous growth determinants A role in growth models for the complex non-linear and interactive behaviour and processes that take place in space Imperfect market conditions in growth models Growth as a long-term competitiveness issue Technological progress as an endogenous factor of growth	Reasons for success and failure of clusters of SMEs, local districts, milieux. Non-material resources as sources of regional competitiveness An active role in knowledge creation
Dynamic rather than static approaches	Evolutionary trajectories of non-linear interdependencies of complex systems	Dynamic rather than static agglomeration economies

Source: Capello (2008a)

The first tendency which has accompanied the theoretical development in the field is the *need for more realism* in sometimes rather abstract conceptual approaches, by relaxing most of the glaringly unrealistic assumptions of the basic theoretical models. This tendency is justified by the

[2] For an extensive review of regional growth theories, see, among others, Johansson et al., 2001.

need to broaden the interpretative capacity of the theoretical toolbox in this research field by searching for theories that are better able to reflect issues and policy strategies for the real world.

In recent years, more realism has been required to insert into growth models the complex non-linear and interactive behaviour and processes that take place in space, and to understand regional competitiveness in terms of endogenous factors. The question of whether a region is intrinsically capable of growing as a result of endogenous forces has been a source of debate for decades; industrial specialization, infrastructure endowment, central location, production factor endowment, or agglomeration economies have all been emphasized in the academic arena as driving forces of local economic success. The theory of industrial organization has also provided important contributions here.

One important step forward in this field has been the focus on economies of scale in production, which, together with non-linear transportation costs, have been introduced into a (quantitative) interregional growth model; the final spatial distribution of activities critically depends on initial conditions, including the starting distribution of activities and the nature of the non-linearities embedded in the activity-transportation interactions, which give rise to multiple equilibria (Krugman, 1991). The additional value of this approach – sometimes referred to as the 'New Economic Geography' – rests in skillfully modelling the interaction between transportation costs and economies of scale in production, although the determinants of endogenous growth have already long been emphasized, starting with the Myrdal-Kaldor model (increasing returns, cumulative self-reinforcing growth patterns). The aim to incorporate agglomeration economies – in the form of increasing returns – into conventional models of a strictly macroeconomic nature was made possible by advances in more sophisticated mathematical tools for the analysis of the qualitative behaviour of dynamic non-linear systems (bifurcation, catastrophe, and chaos theory), together with the advent of formalized economic models which abandoned the hypotheses of constant returns and perfect competition (Fujita and Thisse, 1996 and 2002). Further links to complexity theory are also plausible in this context.

In the spirit of Krugman's efforts, in the field of endogenous determinants great emphasis has recently been put on knowledge as a driving force for development, and, what is really new, on the endogenous self-reinforcing mechanisms of knowledge creation. Macroeconomic models of endogenous growth, where knowledge is generally embedded in human capital (Romer, 1986; Lucas, 1988), have widely dominated the academic arena in the last decade. Their main aim was to insert more realism in growth models by relaxing the unrealistic assumption that technological progress is an exogenous process in an economic system. In the new growth theories, instead, technological progress is regarded as an endogenous response of economic actors in a competitive environment. More specifically, increasing returns in factor productivity stemming from endogenous factors – such as innovation, scale economies, and learning processes – are included in a neoclassical production function, where they offset the effect of the marginal productivity of the individual factors, which the traditional neoclassical approach assumes to be decreasing. These

adjusted assumptions have led not only to interesting analytical findings but also to new far-reaching policy implications.

Endogenous growth theory is already two decades old and has played a central role in the growth debate since the 1990s. The main idea of these new contributions is that technological progress is not exogenously given, but a self-organized response of individual agents in an entrepreneurial business environment. Consequently, in contrast to earlier macroeconomic explanatory frameworks, the emphasis is much more on firms' individual economic behaviour (see e.g., Aghion and Howitt, 1998; and Barro and Sala-i-Martin, 1997). In this way, it can be demonstrated that regional growth is not the result of exogenous productivity-enhancing factors but rather is the result of deliberate choices of individual actors (firms and policy makers). Individual smart behaviour is thus at the centre of this debate.

The strategic relevance of knowledge for innovation and entrepreneurship is thus increasingly recognized. The spatial distribution of knowledge and its spillovers are considered as important success factors for regional development in an open competitive economic system. Thus, the geographical patterns of knowledge diffusion, as well as the barriers to access to knowledge, are decisive for regional development in a modern global and open space-economy. Consequently, knowledge policy – often instigated by ICT advances – is a critical success factor for regional welfare creation (see, e.g., Acs et al., 2002; Döring and Schnellenback, 2006; and Keeble and Wilkinson, 1999), where knowledge refers to education, learning, training, creativeness, and R&D.

It is noteworthy that the identification of endogenous determinants of growth was the crucial scientific issue that explained the birth of regional development theories. Development is in fact by definition *endogenous*. It is fundamentally dependent on the concentrated organization of the territory, embedded in which is a socio-economic and cultural system whose components determine the success of the local economy: entrepreneurial ability, local production factors (labour and capital), and the relational skills of local actors. All these generate cumulative knowledge-acquisition – and, moreover, a decision-making capacity which enables local economic and social actors to guide the development process, support it when it is undergoing change and innovation, and enrich it with the external information and knowledge required to harness it to the general process of growth, and to the social, technological and cultural transformation of the world economy. The micro-behavioural nature of these approaches allowed a deep understanding of the sources of territorial externalities, and of increasing returns in the form of agglomeration economies, which are at the basis of industrial cluster formation. Within this approach, much emphasis is given to the role of entrepreneurship in regional development (Nijkamp and Stough, 2004).

More realism in the study of clusters and their determinants has called for a better understanding of the success and failures of local productive systems, hardly explained in the first theories proposed. Dynamic agglomeration economies – defined as territorial advantages that act on the capacity of firms and regions to innovate – have become the centre of most recent theoretical

reflections in this field, giving rise to neo-Schumpeterian approaches in regional development. A major debate dominates the academic arena, with the aim of identifying the role of space in innovative processes. This has prompted a new strand of growth literature on regions or cities.

In the vast regional and urban literature created in this field, the endogenous determinants of innovation are increasing returns in the form of dynamic locational advantages deriving from[3]: (i) the *spatial, geographical proximity* of firms, which facilitates the exchange of tacit knowledge – this characterizes reflection by economic geographers concerned to explain the concentration of innovative activities; (ii) the *relational proximity* of firms, defined as interaction and cooperativeness among local agents, the source of collective learning processes and socialization to the risk of innovation (i.e. territorialized relations among subjects operating in geographical and social proximity) – this was the approach taken by territorial economists in explaining the dynamics of local systems in terms of local innovative capacity; (iii) the *institutional proximity*, which takes the form of rules, codes and norms of behaviour that facilitate cooperation among actors and therefore the socialization of knowledge and assist economic actors (individual people, firms, and local institutions) to develop organizational forms which support interactive learning processes. This aspect was emphasized by more systemic approaches which sought to understand the evolution of complex systems like the innovative system in a broad global competitive network.

A second clear mega-trend in theoretical developments – typical only of regional development/growth theories – has been the attempts to move towards *dynamic approaches*. Time matters, as well as space, in regional science, and this also holds in regional economics. The effort to encapsulate time in spatial analyses has been accomplished in two different ways, according to two different meanings of time applied in the two fields of analysis: a more traditional chronological time; and time as the rhythm of innovative phenomena which occur in the territory which has been applied in regional growth models all over the world.

The introduction of chronological time within spatial analysis is not at all a simple task, since it requires a mathematical and methodological toolbox, only recently available to regional scientists. Theories on non-linear regional dynamics – framed in the context of chaos theory, synergetics theory, or predator-prey analysis – may be mentioned here (see Nijkamp and Reggiani, 1999). In growth models, until a few years ago, the vast majority of experiments and applications took for granted the existence of linear – and thus regular – growth processes. Linear models are certainly able to generate unstable solutions, but the solutions of such models are restricted to certain regular standard types. Such models may provide approximate replications of short- and medium-run changes, but fail to encapsulate long-term developments characterized by structural shifts of an

[3] For the literature on spatial spillovers, see, amongst others, Anselin et al., 1997 and 2000; Audretsch and Feldman, 1996; Aydalot, 1986; Feldman, 1994; Feldman and Audretsch, 1999; de Groot et al., 2001; Jaffe, 1989; Jaffe et al. 1993; Maier and Sedlacek, 2005; on collective learning, see Bellet et al., 1993; Camagni, 1991; Capello, 1999 and 2001; Crevoisier and Camagni, 2000; Maillat et al., 1993; Rallet, 1993; Rallet and Torre, 1995; Ratti et al. 1997; on learning regions, see Lundvall, 1992; Lundvall and Johnson, 1994; Maskell and Malmberg, 1999; on knowledge-based regions, see Florida, 1995; Malecki, 2000; Nijkamp and Stough, 2004; Simmie, 1997.

irregular nature. This limitation has recently been overcome with the adoption of non-linear models, which allow for a change in the dynamics of a system generated even by small perturbations in structural forms; structural instability means the possible existence of significant qualitative changes in the behaviour of the system (i.e. in the state variables) that are closely connected with bifurcation and catastrophe phenomena, which occur if the parameter values (i.e. the control variables) are changing (see Fujita and Thisse, 1996 and 2002). The application of non-linear models to the well-known neoclassical and Keynesian models has shown that the deterministic and unique results achieved by the dynamic linear models are no longer guaranteed: interregional income convergence determined by the traditional neoclassical model collapses and opens the way to alternative possible trajectories, and equilibria solutions; non-linear Keynesian Myrdal-Kaldor models substitute the deterministic result of continuous growth or decline with new and opposite development trajectories, after catastrophe phenomena occur (Miyao, 1984, 1987a and 1987b). We thus observe a wealth of new theoretical contributions on the dynamics of spatial development.

Such a theoretical improvement has also been useful in achieving a greater realism of these models, which are now able to incorporate the dynamic interactions between the components of a spatial system represented in a network constellation. The latter network approaches are functionally determined by interdependencies between the behaviour of actors and distance frictions. Such spatial interactions may be stable in nature (i.e. operating under fixed external conditions) or subject to change as a result of dissipative evolutionary processes in the external world. In the latter case, model parameters become time-dependent, so that non-linear complex dynamics may emerge (see Puu, 1991; Nijkamp and Reggiani, 1993 and 1999; Nijkamp, 2006).

Next, we also note that, in the field of regional development, conceptually speaking a different concept of time has been developed and applied: time à la Bergson-Heidegger is interpreted as duration and a continuous process of creation, characterized by discontinuity, irreversibility, sequentiality, and cumulativity. Time has thus been conceived by an important part of regional studies as the pace of learning, innovation and creation processes. Local clusters (and industrial districts) are, by definition, the loci where learning and cumulative learning processes take place; the identification of the sources and the endogenous determinants of such processes, apart from simple physical proximity, represents a great challenge for regional economists. Knowledge spillovers, collective learning, learning regions (or learning space), and knowledge-based regions are all theories that embrace the most advanced perspectives in this direction. In these theoretical approaches, therefore, innovation has become the critical survival factor in a competitive space-economy and determines the direction and pace of regional development (Nijkamp and Abreu, 2009).

We may thus conclude that the introduction of micro-based endogenous growth components has led to an enrichment of regional growth theories, in which the role of public policy is no longer seen as a top-down 'control and command' approach, but as a partnership model, in which strategies are to be developed in cooperation with all stakeholders in space.

3. The Challenge of Regional Sustainability

Concern for the local environment is not a recent policy issue. Already in Ancient Rome we find examples of policy measures to mitigate the noise nuisance of horse-drawn carriages during the night. And several medieval cities in Europe had guidelines on where and when to park carriages (including priority rules for wealthy citizens). In the welfare economics literature, such non-market phenomena were called 'externalities'. To guarantee again an equalization of marginal costs and benefits, a system of taxes (or subsidies) was foreseen, so that an optimal market equilibrium could be re-established. These Pigouvian welfare rules were seen as interesting exceptions to an otherwise perfectly working market mechanism.

However, in the age of mass industrialization and large-scale mobility, such externalities became a dominant phenomenon rather that an exception. Already in the 1950s and 1960s, the first voices on environmental decay were heard, often inspired by concerns about declining water quality, noise nuisance, local health, and air pollution. The real breakthrough and awareness took place in the first wave of environmental consciousness, viz. after the publication of the First Report to the Club of Rome in 1973. In this global study, much concern was expressed about environmental pollution, scarcity of natural resources, the threat of the 'population bomb', lack of food, and the position of the developing countries. The next wave of increased interest emerged in 1987, with the publication of the Brundtland Report. This document was greatly concerned about the issue of sustainable development, in particular from the viewpoint of the developing world and from the viewpoint of the next generations. Since then, 'sustainability' has become a fashionable word but, unfortunately, it lacked an operational definition, so that in practice this concept was uncritically used for sectoral development, for regional or local developments, or for development with regard to new generations. However, this concept has prompted an avalanche of research – including applied modelling research – on various elements of local, urban or regional sustainability, from the perspective that our world calls for a holistic view on future development. And, finally, we witness the third wave, where the interest in global developments – such as climate change or the rise in sea level – is anchored in local or regional settings. This embeddedness of the global change debate in local and regional development has prompted new types of research in the area of regional science (see Batabyal and Nijkamp, 2008). From the wide range of issues, we now select five important focal points that serve to illustrate the importance of the recognition of sustainability issues in regional development.

Regional economic development

Regional economic development comprises more elements than regional economic growth: for example, access to social facilities, a healthy living environment, a high quality of education, a sustainable living environment, etc. Such conditions manifest themselves in many facets of the local or regional environment. We mention here three examples:

First, business location is nowadays not a simple cost-minimization question, but a multi-dimensional trade-off of many factors, in which the (image of the) quality of the local environment or access to recreational or sports facilities plays a critical role.

Second, public environmental policies may increase the locational costs of new or incumbent firms, and hence influence their locational decisions. Thus, the way externalities are treated by the public sector will impact on the willingness to invest by business firms.

And, third, the local institutional setting – e.g. the presence of public-private partnerships – may create a sense of common responsibility, also for the local quality of life, so that the institutional structure may be a driving force for local or regional sustainable development.

The welfare of regions and the use of the physical resource base of these regions are clearly mutually interwoven phenomena. It is thus clear that regional economic development and sustainability strategies may be seen as mutually complementary forces that may reinforce each other.

Natural resources

Natural resources may have a productive meaning (e.g. mines, oil reserves) or a consumption meaning (e.g. recreation parks or lakes for sailing or fishing). They may be decisive for balanced regional development, as will now be exemplified by means of three selective illustrations on natural resource use:

First, deforestation may be a wise strategy from a short-term productive perspective, but calls for a careful and balanced policy in view of long-term sustainability. An equilibrium policy that attains a balance between long-term wealth and short-term revenues may therefore be a wise strategy.

A second example concerns water provision and use. The situation regarding the quality of water in many regions and cities is rather critical nowadays, and reqiuuires intensified policy initiatives. Proper management of scarce water reserves – in terms of both quality and quantity – is a conditio sine qua non for healthy and sustainable local and regional development.

A final example concerns waste management. Waste is a necessary by-product of any production and consumption process; it is often a cost factor, but it may be turned into a revenue factor (e.g. in the case of district heating, waste incineration, etc.). Thus, the challenge will be to turn ‘environmental bads’ into ‘environmental goods’ though the proper usage of sticks and carrots. And this calls for operational environmental research at a local scale.

Smart local resource use may improve local welfare conditions. We may conclude, therefore, that proper waste management at local or regional level will create favourable conditions that stimulate balanced local or regional development.

Environmental regulation

Local or regional economic policy is not only a matter of taxes, subsidies or prohibitions but also calls for transparent environmental regulations. We will give a few examples here.

Environmental regulations have often been criticized because they might cost jobs. But this calls for a careful empirical analysis, as there are also many counterfactual findings based on several experiences all over the world. There is an increasing body of literature that demonstrates that strict environmental regulations by no means have a negative effect on economic activity, but most likely a negligible or even positive effect in the long run.

Pigouvian taxation is seen as a proper response to the existence of externalities. This may certainly be true from an economic perspective, but the way such taxes are then allocated is decisive for their political support and acceptability. This is also of great importance for local taxation schemes (e.g. for parking, waste treatment, etc.).

And, finally, the local or regional dimension of environmental policy is of great importance. This has a particular relevance for the local tax base and the distribution of public money in a system of fiscal federalism. Such spatial demarcation issues may greatly impact on local sustainable development.

Environmental regulations may act as competitiveness vehicles in regional development. All in all, we may conclude that spatial heterogeneity in environmental regulation systems will significantly influence the economic and environmental aspects of any sustainable development policy.

Regional climate change

The relationship between global change and local development has often been neglected, but is receiving increased attention. Global warming will certainly have a far-reaching impact on local or regional development conditions, as illustrated by the following examples.

Changes in our ecosystems – with more extremes and outliers – will call for adjusted ecosystems management at local or regional level so that these systems can be better protected against floods or other nature disasters. This may call for other types of land use policy.

Another example concerns the interrelationship between local and global climatic conditions, e.g. in terms of building regulations, or water or energy supply. This prompts increasingly proactive policies, e.g., in the EU.

Many cities are to be found along the coast or river flood plains. The rise in sea level calls for new design and security principles in urban planning in the decades to come. We may clearly draw the conclusion that sustainability policy will call for drastic adjustments of local and regional land use, environmental and resource policy.

Modelling local and regional environments

Much quantitative research has been undertaken in the past few decades to map out the complex policy dynamics of the modern space-economy Computable general equilibrium modelling and simulation modelling have proven to be appropriate tools. More recently, we have seen the emergence of geographic information systems (GIS) as an example of operational model applications. A great many useful applications can be found in the literature.

For instance, several studies have been published on housing planning and demand, with respect not only to the quality of the dwellings in a narrow sense, but also to the neighbourhood and accessibility effects in a broader sense.

Another example concerns location analysis in the context of land use and land values. GIS has been very instrumental in dealing with large spatial data sets, e.g. in evaluating commercial buildings and densities, in making spatial assessment of land values, or in identifying risk-prone areas.

GIS has indeed become an important toolbox for regional science research, but its potential for local or regional socio-economic development policy is still underutilized. There is still a long way to go before geo-science modelling will be an integral part of local or regional development policy.

The interwoven nature of the ecology of our planet – at different geographic scale levels – with local and regional development thus prompts many new research endeavours. There is yet one final question: Has sustainability had an impact on regional development policy, and is there a link to endogenous growth policy? The answer is in the affirmative. Environmental and resource conditions at local or regional scales are no longer permanently given factors. They can be influenced and adjusted by smart and appropriate decisions and investments in both the public and the private sector. In other words, regional sustainable development from an endogenous perspective is the result of deliberate choices and actions of local and regional stakeholders, including public policy-making bodies.

4. New Research Challenges in Regional Growth and Development

The previous observations have clearly demonstrated that, nowadays, fascinating new theoretical challenges are being faced by regional scientists, and have to be addressed. A first challenge emerged from the attempt to obtain advantage from a future convergence in different theoretical approaches, a convergence only partially obtained by the new regional growth theories. New growth theories make a commendable effort to include space in strictly economic models. Also to be commended is the implicit merging in their theoretical structure of the various conceptions of space put forward over the years: that is, the merging of the physical-metric space represented by transport costs with the diversified space, which assumes the existence of certain territorial polarities where growth cumulates. However, the new economic geography is still unable

to combine the economic laws and mechanisms that explain growth with territorial factors that spring from the intrinsic relationality present at local level. Any approach that did achieve this would represent the maximum cross-fertilization between location theory, development theory, and macroeconomic growth theory – a synthesis which would bring out the territorial micro-foundations of macroeconomic growth models.

What is needed, therefore, is a convincing 'umbrella model' that comprises the micro-territorial, micro-behavioural, and intangible elements of the development process. What is required for this purpose is the definition of patterns, indicators, and analytical solutions to be incorporated into formalized models necessarily more abstract and synthetic in terms of their explanatory variables, variables besides the cost of transport, which remove the role of territory in the development process. A move in this direction is the quantitative sociology that embraces the paradigm of methodological individualism and seeks to 'measure' the social capital of local communities. It is obviously necessary to bring out territorial specificities within a macroeconomic model. Or, in other words, it is necessary to demonstrate the territorial micro-foundations of macroeconomic growth models.

Serious risks both from disciplinary barriers and from adherence to interdisciplinary perspectives on strategic problems can be mentioned here. They are the result not only of a regional scientists' narrow perspective, as mentioned by Bailly and Coffey (1994), but also of some rather idiosyncratic attitudes of mainstream disciplines towards a clearly multidisciplinary science like regional science.

In this respect, the following examples may be illuminating. The first concerns the theory on 'social capital' developed by quantitative sociology: the concept could take advantage of, and provide advantage to, all reflections on local synergies and milieu effects developed by regional and urban economists, and by the strategic planning studies in the field of urban planning. The reflections in the field of knowledge spillovers developed by industrial economists could take advantage of regional science concepts of collective learning and relational proximity, in which the endogenous spatial development patterns of knowledge are not left to simple probabilistic contacts, but are explained through territorial processes (Camagni and Capello, 2002). Last but not least, the theoretical reflections that characterize the 'new economic geography' seem to be the result of a skilful effort of a group of mainstream economists, driven, however, by a somewhat inexplicable attitude that denies the importance of well-known spatial concepts (i.e. technological spatial externalities), or (re-)invents important spatial concepts (i.e. cumulative self-reinforcing processes of growth; transportation costs vs. agglomeration economies in location choices). The inevitable consequence of such an attitude is to mix the important and undeniable steps forward made by the 'new economic geography' school with already well-known knowledge in the field of regional science.

Especially in the case of economics, we hope that, after the (re-)discovered interest by mainstream economists in space, and in spatial phenomena, the attitude towards regional science will change in favour of a more cooperative and pronounced interest.

Related to the interdisciplinary challenge, a last important remark is worth mentioning. An interdisciplinary approach should lead scientists to explore new frontiers and achieve new interpretative analytical frameworks. However, the tendency shown in this respect is quite different, being merely inclined to exploit passively the new ideas suggested by complementary disciplines. A case worth mentioning is the enthusiastic way in which regional scientists accepted the spatial spillover theory as a theory that could provide a new interpretation of the role of space as a channel for knowledge transfer.

Instead, a more critical approach to this theory shows that to some extent it has gone some steps backwards in the interpretation of space in spatial knowledge creation. Space is purely geographical, a physical distance among actors, a pure physical container of spillover effects which come about – according to the epidemiological logic adopted – simply as a result of physical contact among actors. Important consequences ensue from this interpretation of space. First, this view is unable to explain the processes by which knowledge spreads at local level, given that it only envisages the probability of contact among potential innovators as the source of spatial diffusion. Secondly, it concerns itself only with the diffusion of innovation, not with the processes of knowledge creation. It thus imposes the same limitations as did Hägerstrand's pioneering model in regard to the spatial diffusion of innovation: the diffusion of knowledge means adoption, and adoption means more innovation and better performance. This ignores, however, the most crucial aspect of the innovation process: how people (or the context) actually learn. This calls for a more thorough and innovative investigation of cognitive processes in a regional context (Capello, 2008b). This is an aspect of overriding interest not only for researchers but also, and especially, for policy makers should they wish to explore the possibilities of normative action to promote local development.

5. Retrospect and Prospect

In the globalization process of creating an open economy, local factors and local specificities are fundamental elements on which the competitiveness of countries depends. They are, therefore, important areas where practitioners and policy makers require a sophisticated and advanced toolbox to intervene.

Regional economics has been subject to varied and creative advances in theoretical economic contributions. Various core tendencies in the development trajectories of the discipline have been stressed in this review, in particular the attempt to introduce more realism into the theoretical approaches, combining rigorous theoretical reflections with an understanding of the reality of place.

The force field of regional welfare is varied and sometimes unpredictable, as the region is part of a complex global system. An important contributor to regional development is technological

progress, an extensively studied topic in the recent economic growth literature. From a geographic (regional, urban, or local) perspective, in recent years much attention has been paid to the spatial conditions that induce technological progress (e.g. entrepreneurial climate, availability of venture capital, incubator facilities, institutional transformations, etc.) (see also Longhi and Musolesi, 2007). Furthermore, the spatial diffusion of technology has also received considerable attention, in particular in the geography literature.

The development of regions in an open world is also strongly influenced by their environmental and resource base. And, therefore, sustainability is a critical task for regional policy as well. This concept is, however, not only a burden but opens the door for new and creative regional growth strategies. In fact, in the last few years, spatial development has been put vigorously on the agenda of policy makers who foresee economic competitiveness as highly dependent on an efficient territorial system of regions and cities. At the European level, the concept of territorial sustainability has come to the fore, meaning the normative aim of complementing economic equity aims with social, environmental and territorial ones.

It is noteworthy that regional scientists increasingly address, in their scientific agenda policy, issues that have a strong societal interest; convergence problems, on the one hand, and endogenous determinants of regional growth (like knowledge creation), on the other. These two themes both have a practical interest and reflect a need for a multidisciplinary approach, providing regional scientists with all the challenges to identify new pathways. Whether this will actually happen is a matter of willingness to grasp the opportunities that are provided in the present era, and to respond to the plea of policy makers for a more locally-oriented understanding of the real world.

The history of regional growth theory covers almost half a century. We have seen a deepening of our understanding of the complex backgrounds of, and impediments to, balanced regional development. But regions are not islands that can be isolated from the rest of the world. They are subjected to the same forces as nations and continents, and, consequently they have to be positioned in a similar conceptual explanatory framework, complemented with regional socio-economic specificities. Regional growth is thus a race without a finish; and that also applies to regional growth theory.

References

Acs, Z.J., Anselin, L. and Varga, A. (2002), "Patents and Innovation Counts as Measures of Regional Production of New Knowledge", *Research Policy*, vol. 31, pp. 1069-1085

Aghion, P., and Howitt, P. (1998), *Endogenous Growth Theory*, MIT Press, Cambridge, MA

Anselin L., Varga, A. and Acs, Z. (1997), "Local Geographic Spillovers between University Research and High Technology Innovations", *Journal of Urban Economics*, vol. 42, pp. 422-448

Anselin L., Varga, A. and Acs, Z. (2000), "Geographic and Sectoral Characteristics of Academic Knowledge Externalities", *Papers in Regional Science*, vol. 79, no. 4, pp. 435-443

Armstrong, H.W. (1995), "Convergence among the Regions of the European Union, 1950-1990", *Papers in Regional Science*, vol. 74, no. 2, pp. 143-152

Audretsch D. and Feldman, M. (1996), "R&D Spillovers and the Geography of Innovation and Production", *American Economic Review*, vol. 86, 3, 630-640

Aydalot Ph. (eds.) (1986), *Milieux Innovateurs en Europe*, GREMI, Paris

Bailly H. and Coffey, W. (1994), "Regional Science in Crisis: a Plea for a More Open and Relevant Approach", *Papers in Regional Science*, vol 73, no. 1, pp.3-14

Barro, R. (1991), "Economic Growth in a Cross-Section of Countries", *Quarterly Journal of Economics*, vol. 106, pp. 407-443

Barro, R.J., and Sala-i-Martin, X. (1991), *Convergence across States and Regions*, Brookings Papers on Economic Activity, no. 1, pp. 107-182

Barro, R.J., and Sala-i-Martin, X. (1992), "Convergence", *Journal of Political Economics*, vol. 100, no. 2, pp. 223-251

Barro, R., and Sala-i-Martin, X. (1997), "Technology Diffusion, Convergence and Growth", *Journal of Economic Growth,* vol. 2, pp.1-27

Batabyal, A.A. and Nijkamp, P. (2008), "Sustainable Development and Regional Growth", R. Capello and P. Nijkamp (eds.), *Handbook of Regional Growth and Development Theories*, Edward Elgar, Cheltenham (forthcoming)

Baumol, W.J. (1986), "Productivity Growth, Convergence, and Welfare: What the Long-run Data Show", *American Economic Review*, vol. 76, no. 5, pp. 1072-1085

Baumont, C., Ertur, C. and LeGallo, J. (2003), "Spatial Convergence Clubs and the European Regional Growth Process, 1980-1995", in B. Fingleton (ed.), *European Regional Growth*, Springer-Verlag, Berlin

Bellet M., Colletis, G. and Lung, Y. (1993), "Introduction au Numéro Spécial sur Economie et Proximité", *Revue d'Economie Régionale et Urbaine*, no. 3, pp. 357-361

Bernard, A. and Durlauf, S. (1995), "Convergence in International Output", *Journal of Applied Econometrics*, vol. 19, pp. 97-108

Bernard, A., and Durlauf, S. (1996), "Interpreting Tests of the Convergence Hypothesis", *Journal of Economics*, vol. 71, nos 1-2, pp. 161-174

Boldrin, M., and Canova, F. (2001), "Europe's Regions. Income Disparities and Regional Policy", *Economic Policy*, vol. 16, pp. 207-253

Borts, G.H. (1960), "The Equalisation of Returns and Regional Economic Growth", *The American Economic Review*, pp. 319-347; reprinted in D. McKee, R. Dean and W. Leahy (eds.) (1970), *Regional Economics: Theory and Practice*, The Free Press, New York, pp. 147-176

Borts, G.H. and Stein, J.L. (1964), *Economic Growth in a Free Market*, New York, Columbia University Press

Borts, G.H. and Stein, J.L. (1968), "Regional Growth and Maturity in the Unites States: a Study of Regional Structural Change", in Needleman L. (ed.), *Regional Analysis*, Penguin Books Ltd., Harmondsworth, pp. 159-197, orig. edn. (1962), in *Schweizerische Zeitschrift für Volkswirtscahft und Statistik*, vol. 98, pp. 290-321

Camagni R. (1991), "Local Milieu, Uncertainty and Innovation Networks: Towards a New Dynamic Theory of Economic Space", in R. Camagni R. (ed.), *Innovation Networks: Spatial Perspectives*, Belhaven-Pinter, London, pp. 121-144

Camagni R. and Capello, R. (2002), "Apprendimento Collettivo, Innovazione e Contesto Locale", in Camagni R. and Capello R. (eds.), *Apprendimento Collettivo e Competitività Territoriale*, Franco Angeli, Milano, pp. 11-26

Cameron, R. (2005), "Spatial Economic Analysis", *Journal of Development Perspective*, vol. 1, no. 1, pp.146-163

Capello R. (1999), "Spatial Transfer of Knowledge in High-technology Milieux: Learning vs. Collective Learning Processes", *Regional Studies*, vol. 33, no. 4, pp. 353-365

Capello R. (2001), "Urban Innovation and Collective Learning. Theory and Evidence from Five Metropolitan Cities in Europe", in M.M. Fischer and J. Froehlich (eds.), *Knowledge, Complexity and Innovation Systems*, Springer, Berlin, Heidelberg, New York, pp. 181-208

Capello R. (2008a), "Regional Economics in Its Fifties: Recent Theoretical Directions and Future Challenges", *The Annals of Regional Science*, Vol. 42, no. 1

Capello R. (2008b), "Spatial Spillovers and Regional Growth: a Cognitive Approach", *European Planning Studies*, forthcoming

Capello R. and Nijkamp, P. (2004), "The Theoretical and Methodological Toolbox of Urban Economics: From and Towards Where?", in R. Capello and P. Nijkamp (eds.), *Urban Dynamics and Growth: Advances in Urban Economics*, Elsevier, Amsterdam, pp. 1-30

Chatterji, M. (1992), "Convergence Clubs and Endogenous Growth", *Oxford Review of Economic Policy*, vol. 8, no. 4, pp. 57-69

Chatterji, M. and Dewhurst, J.H.L. (1996), "Convergence Clubs and Relative Economic Performance in Great Britain: 1977- 1991", *Regional Studies*, vol. 30, no. 1, pp. 31-40

Cheshire, P. and Carbonaro, G. (1995), "Convergence-divergence in Regional Growth Rates: An Empty Black Box?", in H.W. Armstrong and R.W. Vickerman (eds.), *Convergence and Divergence among European Regions,* Pion, London, pp. 89-111

Crevoisier, O. and Camagni, R. (eds.) (2000), *Les Milieux Urbains: Innovation, Systèmes de Production et Ancrage*, EDES, Neuchâtel

Dewhurst, J.H.L., and Mutis-Gaitan, H. (1995), "Varying Speeds of Regional DGP Per Capita Convergence in the European Union, 1981-91", in H.W. Armstong and R.W Vickerman (eds.), *Convergence and Divergence among European Regions,* Pion, London, pp. 22-39

Döring, Th., and Schnellenback, J. (2006), "What Do We Know About Geographical Knowledge Spillover and Economic Growth?", *Regional Studies,* vol. 40, no. 3, pp. 375-395

Fagerberg, J., and Verspagen, B. (1996), Heading for Convergence? Regional Growth in Europe Reconsidered, *Journal of Common Market Studies,* vol. 34, no. 3, pp. 431-448

Feldman, M. (1994), *The Geography of Innovation*, Kluwer Academic, Boston

Feldman, M. and Audretsch, D. (1999), "Innovation in Cities: Science-based Diversity, Specialisation and Localised Competition", *European Economic Review*, vol. 43, pp. 409-429

Fingleton, B. (1999), "Estimates of Time to Economic Convergence: An Analysis of Regions of the European Union", *International Regional Science Review*, vol. 22, no. 1, pp. 5-34

Fischer, M., and Stirbock, C. (2006), "Pan-European Regional Income Growth and Club-Convergence", *Annals of Regional Science*, vol. 40, pp. 693-721

Florida, R. (1995), "Toward the Learning Region", *Futures*, vol. 27, no. 5, pp. 527-536

Fujita, M. and Thisse, J.-F. (1996), "Economics of Agglomeration", *Journal of the Japanese and International Economies*, vol. 10, pp. 339-378

Fujita, M. and Thisse, J.-F. (2002), *Economics of Agglomeration: Cities, Industrial Location and Regional Growth*, Cambridge University Press, Cambridge

Galor, O. (1996), "Convergence? Inferences from Theoretical Models", *Economic Journal*, vol. 106, pp. 1056-1069

Gilles, S.-P. (1998), "The Political Consequence of Unemployment", Working Paper 343, Dept. of Economics, Universitat Pompeu, Fabra

Groot, H. de, Nijkamp, P. and Acs, Z. (2001), "Knowledge Spill-overs, Innovation and Regional Development", special issue, *Papers in Regional Science*, vol. 80, no. 3

Islam, N. (2003), "What Have We Learnt from the Convergence Debate?", *Journal of Economic Surveys*, vol. 17. no. 3, pp. 309-362

Jaffe A., (1989), "Real Effects of Academic Research", *American Economic Review*, vol. 79, pp. 957-970

Jaffe A., Trajtenberg M. and Henderson R. (1993), "Geographic Localisation of Knowledge Spillovers as Evidenced by Patent Citations", *Quarterly Journal of Economics*, vol. 63, pp. 577-598

Johansson B., Karlsson, C. and Stough, R. (eds) (2001), *Theories of Endogenous Regional Growth*, Springer-Verlag, Berlin

Keeble, D. and Wilkinson, F. (1999), "Collective Learning and Knowledge Development in the Evolution of Regional Clusters of High-Technology SMEs in Europe", *Regional Studies,* vol. 33, pp. 295-303

Krugman, P. (1991), *Geography and Trade*, MIT Press, Cambridge, Mass.

Longhi, S., and Musolesi, A. (2007), "European Cities in the Process of Economic Integration: Towards Structural Convergence", *Annals of Regional Science*, vol. 41, pp. 335-351

López-Bazo, E., Vayá, E., Mora A. and Suriñach, J. (1999), "Regional Economic Dynamics and Convergence in the European Union", *Annals of Regional Science,* vol. 33, no. 3, pp. 343-370

Lucas, R. (1988), "On the Mechanics of Economic Development", *Journal of Monetary Economics*, vol. 22, pp. 3-42

Lundvall, B.-A. (1992), "Introduction", in B.-A. Lundvall (ed.), *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, Pinter Publisher, London, pp. 1-19

Lundvall, B.-A. and Johnson, B. (1994), "The Learning Economy", *Journal of Industry Studies*, no. 1, pp. 23-42

Magrini, S., (2004), "Regional (Di) Convergence", in V.J. Henderson and J.-F. Thisse (eds.), *Handbook of Regional and Urban Economics, vol. IV*, Elsevier, Amsterdam, pp. 2742-2796

Maier, G. and Sedlacek, S. (eds.) (2005), *Spillovers and Innovations – Space, Environment and the Economy*, Springer Verlag, Wien

Maillat, D., Quévit M. and Senn, L. (eds.) (1993), *Réseaux d'Innovation et Milieux Innovateurs: un Pari pour le Développement Régional*, EDES, Neuchâtel

Malecki, E. (2000), "Creating and Sustaining Competitiveness", in J.R. Bryson, P.W. Daniels, N. Henry and J. Pollard (eds.), *Knowledge, Space, Economy*, Routledge, London, pp. 103-119

Maskell, P. and Malmberg, A. (1999), "Localised Learning and Industrial Competitiveness", *Cambridge Journal of Economics,* vol. 23, pp. 167-185

Miyao, T. (1984), "Dynamic Models of Urban Growth and Decay: a Survey and Extensions", paper presented to the second World Conference of Arts and Sciences, Rotterdam, 4-15 June

Miyao, T. (1987a), "Dynamic Urban Models", in Mills E. (ed.), *Urban Economics; Handbook of Regional and Urban Economics*, North-Holland, Amsterdam, vol. 2, pp. 877-925

Miyao, T. (1987b), "Urban Growth and Dynamics", in E. Mills (ed.), *Urban Economics. Handbook of Regional and Urban Economics*, North-Holland, Amsterdam, pp. 1-41
Nijkamp, P. (2006), "Ceteris Paribus: Spatial Complexity and Spatial Equilibrium. An Interpretative Perspective", mimeo available from the author
Nijkamp, P. and Abreu, M. (2009), "Regional Development Theory", Encyclopedia of Geography (forthcoming).
Nijkamp, P. and Reggiani, A. (eds.) (1993) , *Nonlinear Evolution of Spatial Economic Systems*, Springer-Verlag, Berlin
Nijkamp, P. and Reggiani, A. (1999), *The Economics of Complex Spatial Systems*, Elsevier, Amsterdam
Nijkamp, P. and Stough, R. (eds.) (2004), *Entrepreneurship and Regional Economic Development*, Edward Elgar, Cheltenham
Okun, A.M. (1970), *The Political Economic of Prosperity*, Brookings Institute, Washington DC
Paldam, M. (1987), "How Much Does one Percent of Growth Change the Unemployment Rate?", *European Economic Review*, vol. 31, pp. 306-313
Patuelli, R. (2007), *Regional Labour Markets in Germany*, PhD Dissertation, Free University, Amsterdam
Puu, T. (1991), *Non-linear Economic Dynamics*, Springer-Verlag, Berlin
Quah, D.T. (1996), "Empirics for Economic Growth and Convergence", *European Economic Review*, vol. 40, no. 6, pp. 1353-1375
Rallet, A. (1993), "Choix de Proximité et Processus d'Innovation Technologique", *Revue d'Economie Régionale et Urbaine*, no. 3, pp. 365-386
Rallet, A. and Torre, A. (eds.) (1995), *Economie Industrielle et Economie Spatiale,* Economica, Paris
Ratti, R., Bramanti, A. and Gordon, R. (eds.) (1997), *The Dynamics of Innovative Regions*, Ashgate, Aldershot
Rey, S.J., and Mantouri, B.D. (1999), "US Regional Income Convergence: A Spatial Econometric Perspective", *Regional Studies*, vol. 33, no. 2, pp. 143-156
Romer, P. (1986), "Increasing Returns and Long-Run Growth", *Journal of Political Economy*, vol. 94, no. 5, pp. 1002-1037
Sala-i-Martin, X. (1996), "The Classical Approach to Convergence Analysis", *Economic Journal*, vol. 106, pp. 343-370
Simmie, J. (ed.) (1997), *Innovation, Networks and Learning Regions*, Jessica Kingsley, London
Solow, R. (1956), "Contribution to the Theory of Economic Growth", *Quarterly Journal of Economics*, vol. 70, pp. 65-94
Stimson, R., Stough, R., and Roberts, H. (2006), *Regional Economic Development*, Springer-Verlag, Berlin